Space Weather Technical Forecast

Issued on Tuesday, 02 May 2023 at 13:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Risk of R1 Minor - R2 Moderate radio blackouts. Very slight chance of R3 Strong radio blackouts and G1/Minor Storm conditions. Active electron fluence continuing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with an impulsive M7.1 flare peaking at 01/1309 UTC, originating from AR3288 in the southwest quadrant. There are currently five numbered and three unnumbered sunspot regions on the visible disc. AR3288 remains the largest group, consisting of a number of mature spots and a small delta spot in the intermediate portion of the region. AR3293 near the northeast limb is rotating into better view and appears to contain several mature spots as well as a small, but well defined delta spot in the intermediate portion of the group. AR3289 just east of the north-centre disc is a relatively compact region with fluctuation in the intensity of its intermediate spots, although it appears stable for now. A fairly large, unnumbered sunspot region has emerged over the east limb, although it is difficult to get a detailed analysis due to foreshortening. A new region with bright flux is appearing over the eastern limb in the northern hemisphere and appears to contain at least one large, mature spot. The remaining sunspot regions on the disc are small and simple. There are a number of potentially eruptive filaments on the Earth-facing disc, however no new Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by ACE and DSCOVR at L1 was broadly indicative of a waning fast wind influence from CH96/-. Solar wind speeds have varied somewhat erratically between 470-530km/s, but has settled more recently to around 490km/s (slightly elevated). The density has varied between average and below average levels, though has been more persistently below average since 02/0000 UTC. The total IMF, Bt, was weak below 6nT with the north-south component Bz varying between +6 nT and -6 nT. The phi angle was initially positive (away from Sun) but has been mostly negative (towards the Sun) since 01/1800 UTC. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, has been at background levels throughout. High energy electron flux (greater than 2MeV) as measured at GOES16, has been at mostly High levels, peaking at 8860 pfu at 01/1600 UTC. The 24-hour integrated fluence was at Active levels, with an increasing then decreasing trend, with 4.68e8 integrated pfu recorded at 02/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a very slight chance of becoming High, mainly on days 1 and 2 (02/03 May).

Solar Wind / Geomagnetic Activity: There are several CMEs which are expected to largely miss Earth in the coming days, however some glancing influences cannot be ruled out. The most likely candidate CME to affect Earth left the Sun on the 29 Apr and is expected to pass by late on day 1 or early day 2 (02 or 03 May). Current fast wind conditions are expected to gradually ease towards background levels, although some peripheral enhancement is also possible from another coronal hole fast-wind on day 1 and 2 (02 and 03 May). The next high-speed stream is

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likely to be from a coronal hole in the southern hemisphere near centre-disc, although this is just beyond the current forecast period. Geomagnetic activity is expected to be Quiet to Unsettled, but with ongoing chance of Active intervals, mainly late day 1 (02 May) or early day 2 (03 May) and a slight chance of G1 Minor Storm intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to persist at background levels. However count rates may increase with any significant flares that occur, mainly from the southwest or northern central sunspots, with a very slight chance of reaching the S1 Minor Radiation Storm threshold. High energy (greater than 2MeV) electron flux is expected persist at mainly High levels, but with peak levels probably gradually declining in the coming days. Any CME arrivals have the potential to suppress flux levels further, reducing confidence from the end of day 1 (02 May) onwards. The associated 24 hour Electron fluence is currently above the Active level (1e8 integrated pfu) threshold and expected to persist at this level until at least day 3 (04 May).

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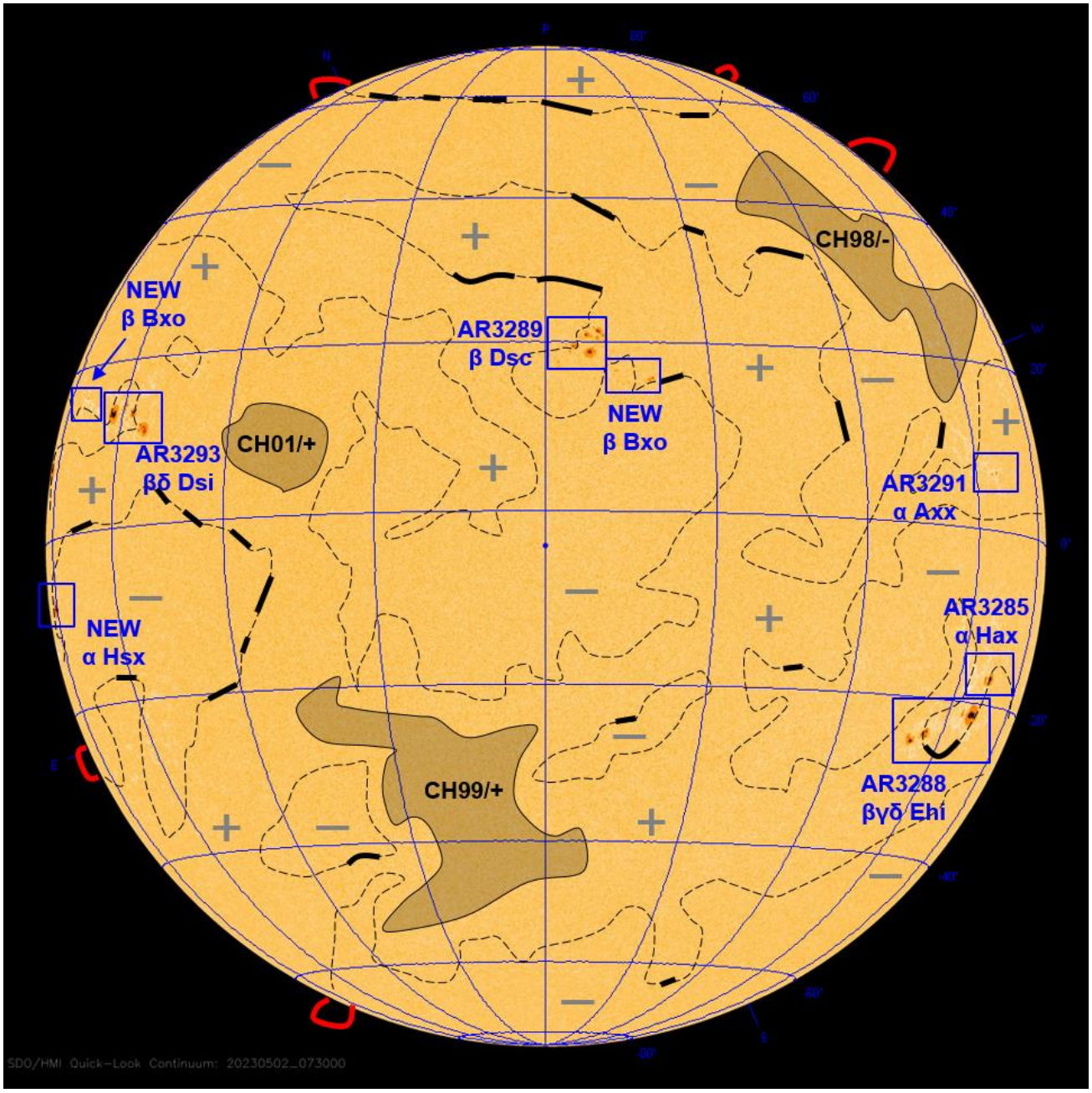
Figure 1. Solar Analysis Valid 02/0730 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There have been numerous mainly faint filament eruptions resulting in observable CMEs over the past few days. These have been assessed as largely missing Earth, however some glancing influences are possible on all days (02-05 May) due to their proximity as they pass Earth. The most likely of these to give any noticeable impact is from a CME which left the sun early on 29 Apr from near AR3288. Any interaction from this is likely to be late on day 1 or early day 2 (02-03 May) as it passes mostly to the south of Earth. A large asymmetric near full-halo CME evident in LASCO and STEREO-A imagery beginning around 02/0400 UTC is far-sided and not expected to affect Earth.

The current fast wind from CH96/- is expected to continue easing, with slightly elevated speeds declining erratically towards background speeds by day 2 (03 May). This is only moderate confidence, however, as CH98/- in the northwest may prolong the slightly elevated winds until day 3 (04 May), although any HSS from this feature is currently signaled by Enlil to pass largely north of Earth. No other significant enhancements are expected in the forecast period with the next HSS from CH99/+ in the southern hemisphere near centre-disc not anticipated at Earth until 06 May.

Geomagnetic activity is expected to be Quiet to Unsettled, but with ongoing chance of Active intervals from any CME influence, most likely late day 1 or into day 2 (02 or 03 May) and a slight chance of G1 Minor Storm intervals. Any influence from CH98/- HSS also brings the chance of isolated Active intervals on day 1 (02 May).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	15	10	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/1002	Partial	Filament Eruption	S disc near AR3288	510 km/s	02/2200 UTC +/- 12 hours	Glancing impact likely late 02 or eary 03 May

Figure 2: Latest Enlil output showing possible arrival of CME late on 02 May. Ensemble plot below suggesting a chance of other CME arrivals during the coming days.

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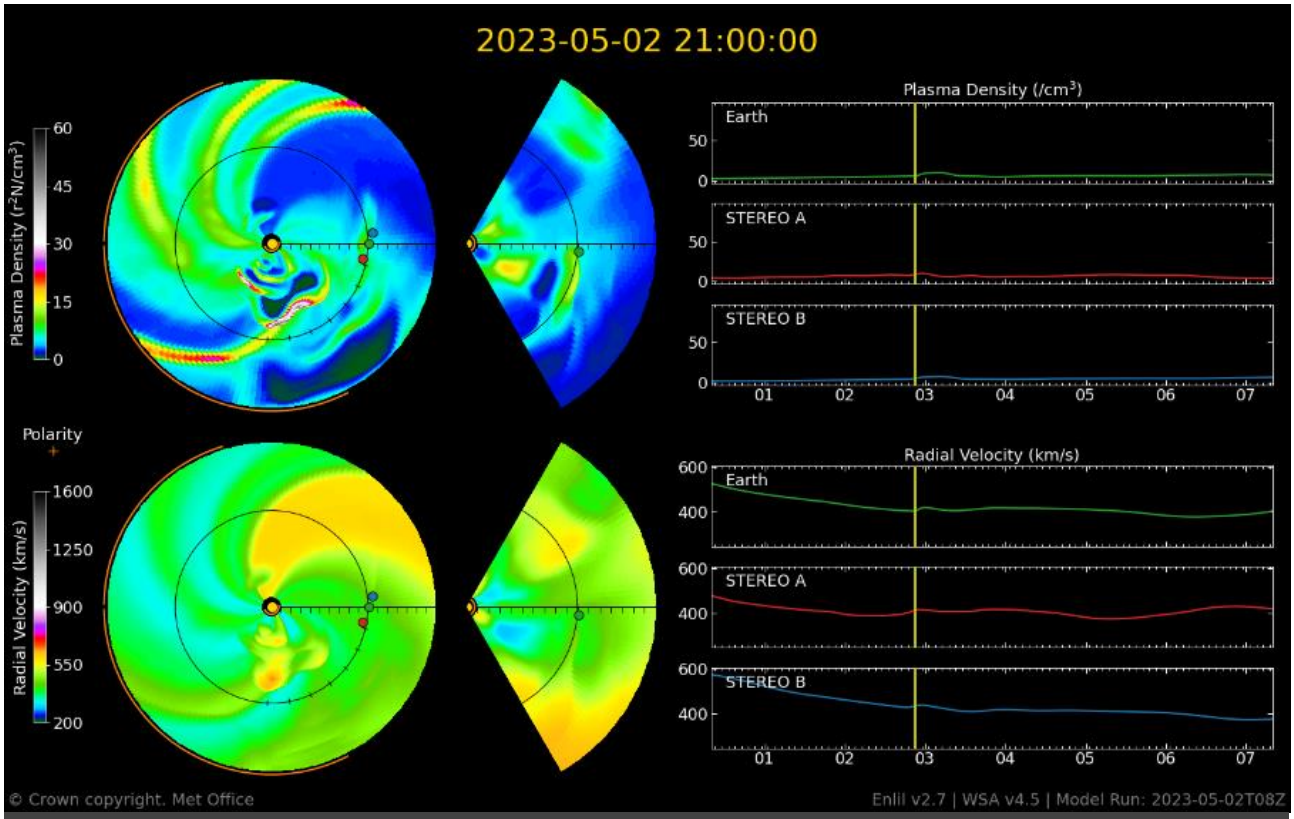

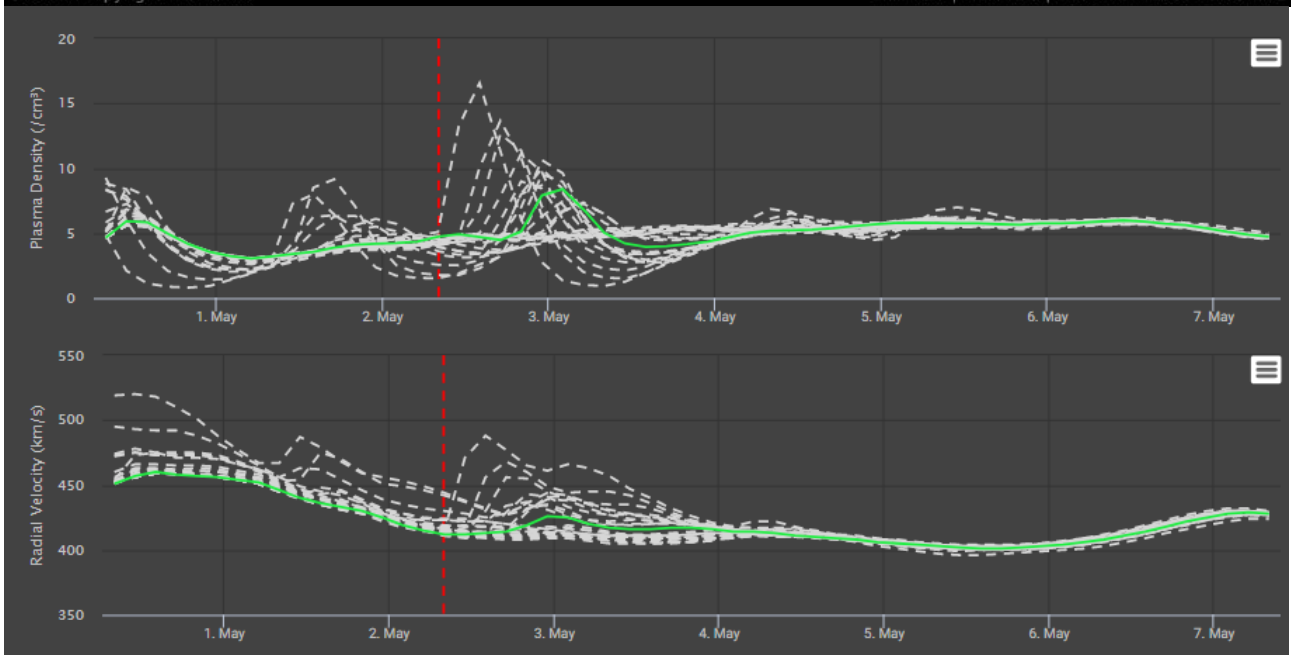

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Radio Blackouts - X-Ray Flares:

Of the eight sunspot regions on the disc, three of them are currently considered the most likely source regions of any notable flaring. The first of these is AR3288 in the far southwest. This is a wide region consisting of a number of mature spots with strong umbra and symmetric penumbra, including a clear, albeit small delta spot. The region is close to AR3285, a large but simple spot to its northwest that further complicates the magnetic looping of this region. These regions will rotate over the western limb on 04 May.

The second is AR3289, just east of the north-central disc and is a compact, small region consisting of several separate penumbra areas each with small umbra. This previously contained a small delta spot but has since faded. A new and currently unnumbered sunspot region emerged to the southwest of AR3289, although this appears to be fading now.

The third is AR3293 close to the northeast limb. The region has been the source of an M-flare as well as occasional low-mid level C-class flares. Now in better view, it appears to contain a small, but well defined delta spot in the intermediate portion of the group.

An unnumbered sunspot region has emerged over the east limb, which appears to be in a large Hsx/Alpha configuration at present, although difficult to get a detailed analysis due to foreshortening. This region is likely to be ex-3280 from the previous rotation. A new region with bright flux is appearing over the eastern limb in the northern hemisphere. It appears to contain a large spot and may be the returning ex-3273. This region is coincident with the bright flux region seen on EUVI/AIA 195 imagery.

Moderate to Low activity is expected with further M-flares (R1-R2 Radio blackouts) likely and a slight chance of becoming High from any isolated X-flares (R3 Radio blackouts). Flare probabilities reduce slightly by day 3 (04 May) as a couple of sunspot groups are due to rotate off the disc, although may be counteracted by the new regions in the far east.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	40	40
Very Active	R3 to R5 X Class	No	10	10	5	5

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux as observed by GOES-16 is forecast to remain at background, with no solar radiation storms expected. Any significant flares, primarily from AR3288 or AR3289, have the potential to increase the observed flux towards the S1 Minor radiation storm threshold, with a very slight chance of exceeding.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux as observed by GOES-16 at GEO is expected to continue at mainly High levels through the coming days, though probably becoming moderate or background at times of diurnal minima. Confidence falls by the end of day 1 due to the chance of CME arrivals, which have the potential to suppress the observed flux further if they occur. However, these are generally expected to miss Earth with mainly High levels continuing. By day 3 and 4 (04 and 05 May) more prolonged periods of Moderate to Background flux are likely, especially during the diurnal minimum period, with peak flux gradually declining.

Electron fluence is currently above the Active (1e8 integrated pfu) threshold and is likely to stay that way through the early period, but with an erratically decreasing trend. There are very slightly elevated probabilities of Very High fluence being reached on day 1 and 2 (02 and 03 May). Confidence reduces day 3 (04 May) onward, due to uncertainties about how quickly peak flux values will decay, along with the potential for any CME arrivals resulting in flux dropping out. REFM supports a declining trend, however this is currently considered likely too rapid with its decline.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	100	80	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	5	5	1	1

Figure 3: GOES-16 Electron Flux and Fluence with REFM

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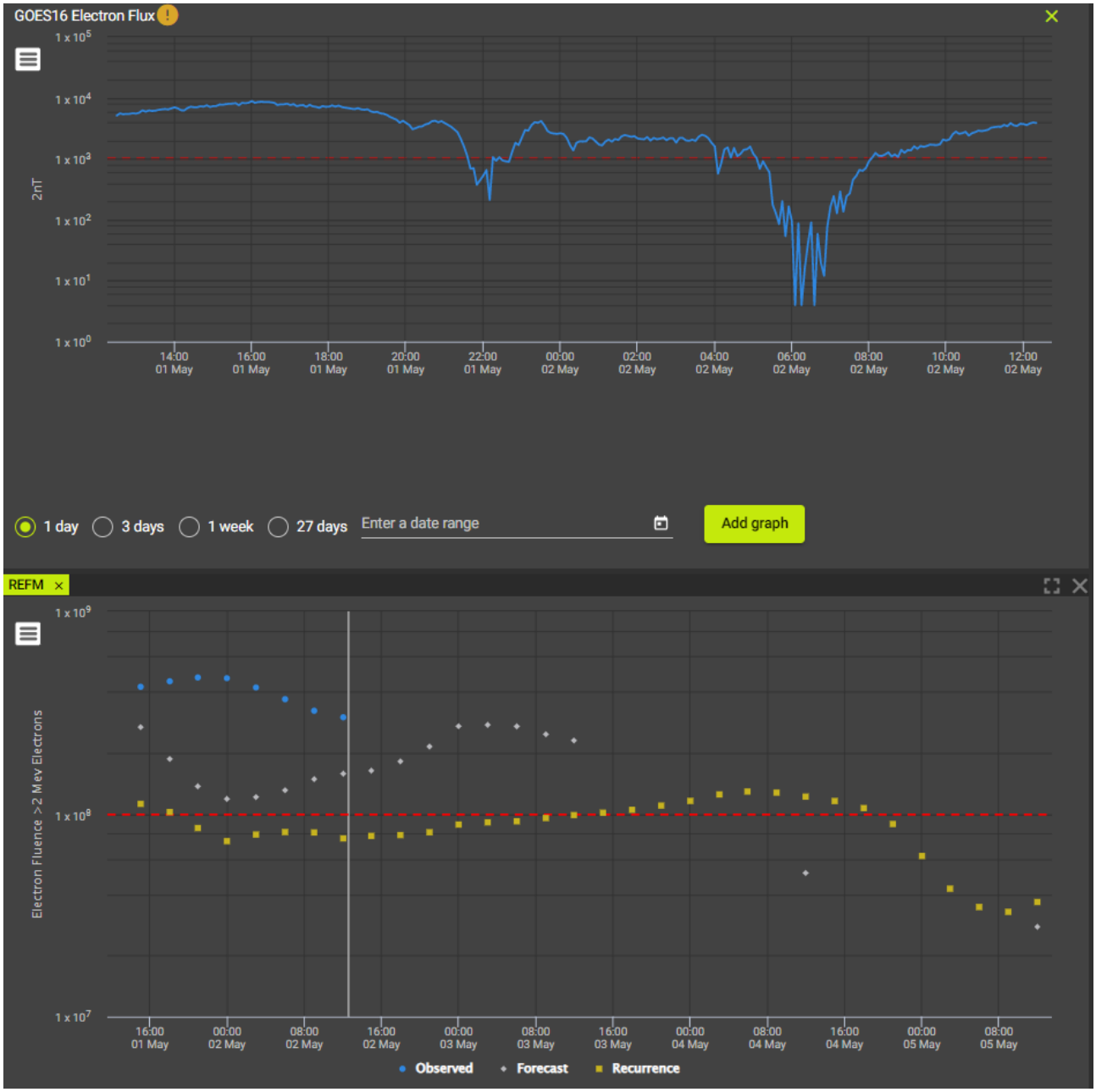

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